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FORMAT PRACTICES FOR DOCUMENTING TIME CRITICAL, HAZARDOUS PROCEDURES

BioTechnology, Incorporated
Falls Church, Virginia

June 1976

OFFICE OF NAVAL RESEARCH

Final Report

FORMAT PRACTICES FOR DOCUMENTING TIME CRITICAL, HAZARDOUS PROCEDURES

June 1976

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Technical Manuals (TMs) include procedures for operating or maintaining equipment under normal and emergency conditions. Invariably, emergency conditions require an immediate and accurate response demanding that the performer knows precisely what to do and when and how to do it. Since the performer is not free to refer to TM under these conditions, TM coverage of emergency procedures should but frequently does not employ formats which emphasize clarity, learning and recall.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

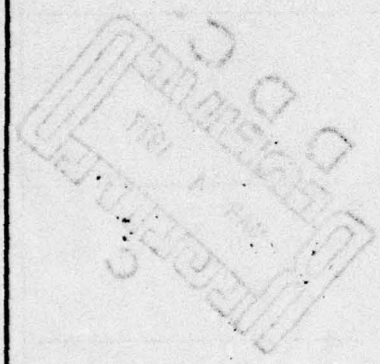
This project used the procedure for ejecting from a disabled aircraft to study this topic. Specific objectives were to:

1. Identify format rules which should be used to present emergency information,

2. Use these rules to assess formats currently in use, and

3. Obtain user opinions of presentations prepared in accordance with the new format rules. Major finds are as follows:

- o 20 format rules were identified; 15 for procedures and 5 for narrative-graphic presentations.
- o 4 sample presentations taken from current pilot handbooks were found to violate these rules.
- o When asked to compare current presentations against a format prepared with the new rules, operational flight crew personnel strongly endorsed the new format.



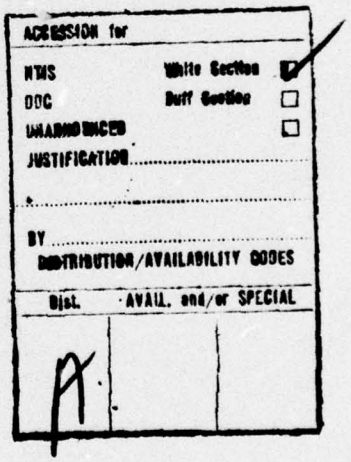
OFFICE OF NAVAL RESEARCH

Final Report

FORMAT PRACTICES FOR DOCUMENTING TIME CRITICAL, HAZARDOUS PROCEDURES

By

Theodore J. Post



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FOREWORD AND ACKNOWLEDGMENTS

The Naval Ship Research and Development Center (NSRDC) is the lead laboratory in a Navywide program to improve Technical Manuals (TMs). In coordination with Crew Systems Division, Naval Air Systems Command, NSRDC commissioned this study to determine whether reformatting relevant sections of the pilots' NATOPS* manual was a feasible means of improving the success achieved in ejecting from disabled aircraft.

The feasibility study was conducted as part of an ongoing investigation of ejection characteristics which BioTechnology, Inc. is conducting under contract to the Office of Naval Research and the Bureau of Medicine and Surgery.

The project monitors for the NATOPS feasibility study were:

Mr. Thomas Pugh – Crew Systems Division

Mr. Joseph Fuller – Naval Ship Research and Development Center

Mr. Robert Sulit – Naval Ship Research and Development Center

*Naval Air Training and Operating Procedures Standardization.

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BACKGROUND

Technical Manuals (TMs) support a multitude of jobs performed by operators and technicians of Navy systems. TMs provide this support in several ways depending on the job being supported. For example, the TM is used as a *reference manual* when a technician looks up part numbers; and the TM serves as a *job guide* when a technician refers to detailed instructions to repair the cause of a malfunction; and, the TM is used as a *learning aid* when a pilot memorizes the procedures of an emergency action. The format features of TMs should, but frequently do not, match the use being made of the TM. Failure to provide formats which match TM usage diminishes the potential effectiveness of the TM. Such failures are particularly apparent in TM passages which present *hazardous*, *time-critical* procedures which the user must learn.

An example of such a situation is the pilots' NATOPS manual – Naval Air Training and Operating Procedures Standardization Manual. The Emergency section of this TM contains procedures and supporting information which the pilot or crewmember must apply without delay. Therefore, the TM presentation of this information should be designed (formatted) to foster learning and recall. Yet, aside from the fact that the time-critical and hazardous procedures appear in the Emergency section of the manual, seldom do their formats differ appreciably from their counterparts in the Normal Procedures section. In other words, the formats used to present emergency procedures do not appear to include features designed to foster learning and recall.

The purpose of this study is to examine a particular emergency procedure in order to verify this contention, and if verified, to establish the feasibility of using specially prepared formats for correcting it. Specifically, the study included the following steps:

1. select a particular emergency procedure to use as a sample;
2. identify format rules which have been shown to enhance learning and recall;
3. reformat the sample procedure in accordance with the proposed presentation rules; and
4. ask pilots and crewmembers to express their preferences for the original or reformatted presentations.

The remainder of this report discusses each of these steps ending with recommendations for continuing the program to improve the TM presentation of this critical information.

CHOICE OF EMERGENCY PROCEDURE

The TM presentation to be used in this study must involve a procedure with the following characteristics:

(1) *Time-Critical.* The procedure must be one whose timing (initiation and completion) is urgent. The implication is that the pilot or crewmember will not have time to look up the procedure; he will have to recall it from prior learning.

(2) *Hazardous.* The procedure must involve decisions or actions which are inherently hazardous to the performer or his equipment. Again the implication is that the performer must know the procedure extremely well.

Ejection from an aircraft was chosen as a procedure which possessed these characteristics. The treatment of this topic in the Emergency Section of the NATOPS TM usually includes two types of information.

(1) *Envelope.* This type of information uses aircraft flight parameters (usually in narrative-graphic form) to indicate the limitations of the ejection system. A sample of this information is shown in Figure 1 which presents safe ejection altitudes as a function of aircraft airspeed and dive angle. Figure 1A shows the graphic portion of the presentation while Figure 1B shows the narrative portion.

(2) *Procedures.* This information presentation uses narrative and pictorials to describe the procedures necessary to operate the ejection system. Figure 2 presents a sample of this type of information (both Figures 1 and 2 were taken from the F-4J NATOPS manual, the source of material used throughout this study).

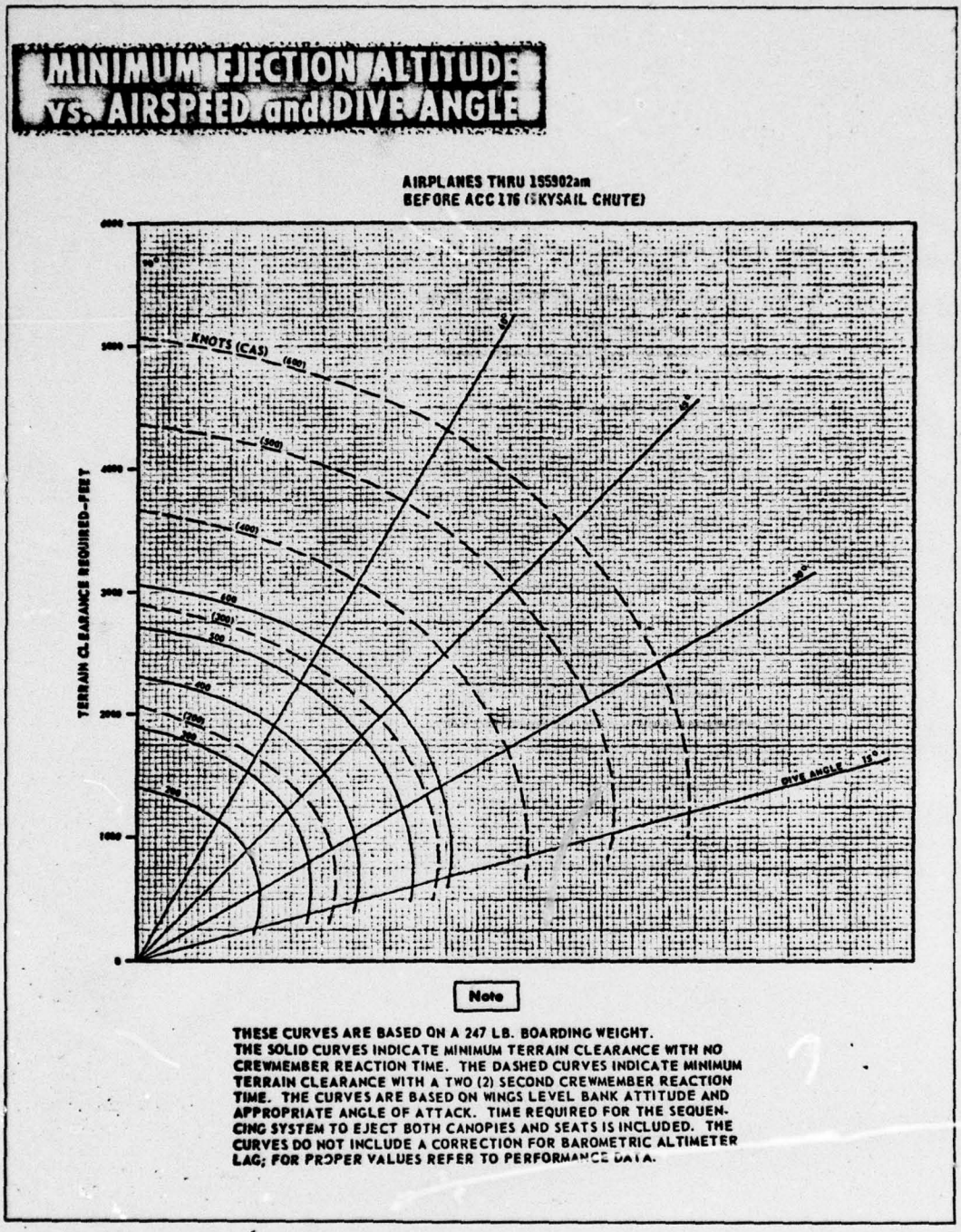

Figure 1A. Sample of Envelope Presentation (Graphic, Partial)

LOW ALTITUDE EJECTION

Low altitude ejection must be based on the minimum speed, minimum altitude and sink rate limitations of the ejection system (figures 5–2 thru 5–5). Figures 5–2 and 5–3 show minimum ejection altitude for a given sink rate, and figures 5–4 and 5–5 show minimum ejection altitude for a given airspeed and dive angle, such as encountered in a dive bombing run. Although these figures indicate minimum ejection altitudes based on seat capability and a representative pilot reaction time, the ultimate decision as to which altitude to eject must be made by the pilot. The minimum ejection altitude charts are based on a 247 pound boarding weight which is defined to include the crewman, his clothing, and personnel equipment, excluding his parachute and seat pan survival kit. Ejection at low altitudes is facilitated by pulling the nose of the airplane above the horizon (zoom up maneuver). This maneuver affects the trajectory of the ejection seat providing a greater increase in altitude than if ejection is performed in a level flight attitude. This gain in altitude increases time available for seat separation and deployment of the personnel parachute. Ejection should not be delayed when the aircraft is in a descending attitude and cannot be leveled out. Assuming wings level and no aircraft sink rate, the ejection seats provide safe escape within the following parameters:

a. Ground level (zero altitude) – zero airspeed. (canopy must be closed)

b. Ground level and up – 400 knots maximum (based on human factors) – 500 knots or M equal 0.92 maximum, whichever is less (based on seat limitations)

At airspeeds greater than 400 knots, appreciable forces are exerted on the body which makes escape more hazardous.

HIGH ALTITUDE EJECTION

For a high altitude ejection, the basic low level ejection procedure is applicable. Furthermore, the zoom up maneuver is still useful to slow the airplane to a safer ejection speed or provide more time and glide distance as long as an immediate ejection is not mandatory. If the aircraft is descending uncontrolled as a result of a mid-air collision, control failure, spin, or any other reason, the pilot and RIO will abandon the aircraft at a minimum altitude of 10,000 feet above the terrain if possible. If the pilot has decided to abandon the aircraft while still in controlled flight at altitude, the pilot and RIO will abandon the aircraft at a minimum altitude of 10,000 feet above the terrain with the aircraft headed to sea or toward an unpopulated area.

Figure 1B. Sample of Envelope Presentation (Narrative, Partial).

BEFORE EJECTION SEQUENCE

TYPICAL BOTH COCKPITS

If time and conditions permit -

- IFF EMERGENCY
- MAKE RADIO DISTRESS CALL
- SLOW AIRPLANE AS MUCH AS POSSIBLE.
- STOW ALL LOOSE EQUIPMENT
- PULL EMERGENCY VENTILATING KNOB TO MINIMIZE DECOMPRESSION EFFECTS WHEN JETTISONING THE CANOPY.

1. ALERT RIO

2. ASSUME PROPER EJECTION POSITION

ADJUST SEAT POSITION SO TOP OF HELMET IS BELOW FACE CURTAIN HANDLES. BRACE THIGHS ON SEAT CUSHION, LEGS EXTENDED. SIT ERECT, BUTTOCKS BACK, SPINE STRAIGHT, HEAD BACK AGAINST HEADREST, AND CHIN IN.

Note

- THE LOWER EJECTION HANDLE SHOULD BE USED WHEN IT IS NECESSARY TO RETAIN CONTROL OF THE AIRCRAFT AND WHEN IT IS IMPRACTICABLE TO REACH THE FACE CURTAIN HANDLE.

WARNING

- IF CREWMEMBER ELECTS TO USE LOWER EJECTION HANDLE AFTER PULLING FACE CURTAIN HANDLE, THE FACE CURTAIN HANDLE SHOULD BE RETAINED WITH ONE HAND TO PREVENT THE POSSIBILITY OF ENTANGLEMENT WITH DROGUE GUN WHEN IT FIRES.

3. FACE CURTAIN HANDLE-PULL

REACH OVERHEAD, WITH PALMS AFT KEEPING ELBOWS TOGETHER, GRASP FACE CURTAIN HANDLE. PULL FACE CURTAIN AND MAINTAIN DOWNWARD FORCE UNTIL STOP IS ENCOUNTERED. WHEN CANOPY JETTISONS, CONTINUE PULLING FACE CURTAIN UNTIL PULL TRAVEL IS REACHED.

3. LOWER EJECTION HANDLE-PULL

GRASP THE LOWER EJECTION HANDLE USING A TWO-HANDED GRIP WITH THE THUMB AND AT LEAST TWO FINGERS OF EACH HAND. PULL UP ON LOWER HANDLE UNTIL STOP IS ENCOUNTERED. WHEN CANOPY JETTISONS, CONTINUE PULLING UP ON LOWER EJECTION HANDLE UNTIL FULL TRAVEL IS REACHED.

WARNING

DURING THE SINGLE EJECTION FROM THE REAR COCKPIT, THE SEAT CATAPULT WILL NOT FIRE AUTOMATICALLY AS IN DUAL EJECTION, AND THE CREWMAN MUST CONTINUE PULL ON THE EJECTION HANDLE AFTER CANOPY REMOVAL TO FIRE THE SEAT GUN. ON AIRCRAFT 155903up AND UP AND ALL OTHERS AFTER AFC 482, THE SEQUENCING SYSTEM AUTOMATICALLY FIRES THE SEAT AND NO EXTRA PULL IS REQUIRED.

Figure 2. Sample of Procedure Presentation (Partial).

POTENTIAL BENEFITS OF A TM IMPROVEMENT

The Naval Safety Center (Rice and Austin) studied ejection experiences to determine the reliability or success rate achieved in this time critical, hazardous performance. Figure 3 summarizes some of the Safety Center findings for the calendar years 1968 and 1969. The chart shows that 57 of the 446 ejections (or 13%) occurred outside of the limitations of the ejection system, viz., outside the "envelope". The chart also shows that these 57 ejections included a disproportionate 70% of the fatalities. Thus, a TM improvement objective should be to enhance the clarity and recallability of the limits perscribed by the NATOPS manual.

Table 1 presents Naval Safety Center data (Rice and Ninow) dealing with injuries sustained as a result of ejecting from aircraft. As shown, 206 injuries occurred during the reporting period (calendar years 1969 through 1971). Although no breakdown of injury cause was given in this Safety Center study, it seems reasonable to assume that faulty procedures, especially body positioning, were an involved factor in many of the injuries. Therefore, a second TM improvement objective is to enhance the clarity and recallability of the prescribed procedures.

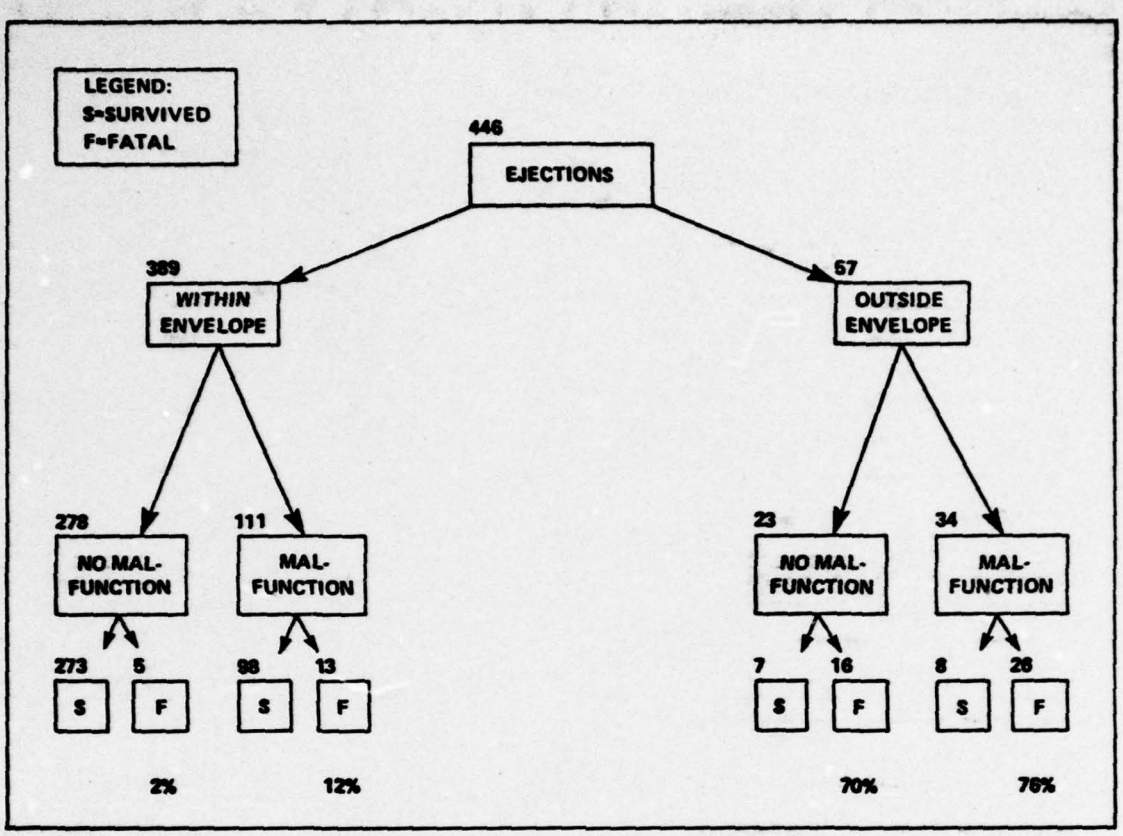

Figure 3. Ejection Successes/Failures.

Table 1

All Egress Injuries – Reported Causes

Cause	Axial	Arm	Leg	Totals
Body position	46	1	2	49
Ejection force	45	2	1	48
Hit cockpit	4	29	38	71
Seat slap			25	25
Restraints			9	9
Misc./Unk	1	2	1	4

FORMAT RULES TO ENHANCE CLARITY AND RECALL

For the purposes of this study format is concerned with communication *means* (e.g., pictorial, narrative, graphic and combinations) and with layout of these communication means. However, since it is difficult to divorce format from information content, these latter considerations are also included in the definition. This section presents 15 format rules related to the presentation of procedural information and 5 format rules related to the presentation of narrative-graphic information viz., the envelope. Both sets of format rules stress the clarity and recallability of the presented information.

Procedural Presentation

Fifteen formatting rules were selected from the literature (Post and Price, 1974) on the basis of their ability to enhance clarity and recall of procedural presentations. Figure 4 lists these fifteen rules in abbreviated form.

1. Steps should be isolated from each other, not embedded in paragraphs.
2. Steps should be grouped, no more than 6 in a "burst" or frame.
3. Limit step content to 2 or 3 thoughts, 25 words.
*4. Each relevant equipment, control, or display should be illustrated.
*5. Relevant equipment features in the illustration should be labeled and highlighted with an arrow.
*6. Provide no more than 6 or 7 callouts for each illustration.
*7. Place illustrations immediately adjacent to relevant text.
*8. Prepare all illustrations as line drawings as opposed to photographs.
*9. Where possible, orient the illustrations to the user's view.
*10. Illustrate the user's hands or body features when an unusual or critical posture/manipulation is being described.
11. Use the second person imperative for textual steps.
*12. Use context illustrations *and* blowups to help identify relevant equipment.
*13. Use one fourth of an inch as the minimum dimension for relevant equipment (in blowups).
14. Use familiar words, preferably from screened list of verbs and nouns.
15. Explicitly describe the user's action.

*Involve illustrations.

Figure 4. Formatting Rules for Procedural Presentations.

Nine of these rules (noted by asterisk) relate to the use of pictorials. This emphasis reflects the unambiguous nature and recallability of presentations whose balance favors the pictorial over the narrative means of communication (Booher, 1972; Sitterly, 1974).

System Limitations (Envelope)

The NATOPS presentations relating to the limitations of the ejection system rely heavily on graphic charts supported by narrative discussion. The formatting rules relating to the clarity and recall of this type of material appear in Figure 5.

1. Use cryptic presentations in tabular or chart form as the primary means of communication.
2. Support graphics with narrative discussion.
3. Use the directive form of instruction (tell the user what to do and when to do it).
4. Minimize the user's need to translate to his current situation (present the information in a form which is directly usable).
5. Locate related narrative and graphic presentations so they can be viewed simultaneously.

Figure 5. Formatting Rules for Narrative-Graphic Presentations.

COMPLIANCE OF SAMPLE PRESENTATIONS WITH FORMAT RULES

The ejection information in four NATOPS manuals was reviewed to determine level of compliance with the formatting rules presented in Figures 4 and 5. Table 2 shows the results of this review for the procedural portions of the presentations. As shown:

(1) Six or more violations were found in all manuals; and

(2) Manuals erred consistently on many rules relating to pictorials (*).

Table 2

Compliance of Four Sample Presentations (Procedural) Against Format Rules

Format Rules	Aircraft Manuals			
	F-14	A-7	AV-8	F-4
1. Isolate steps	√	O	O	X
2. Six steps per frame	√	√	√	√
3. Two or three thoughts per step	√	√	√	√
*4. Illustrate each equipment feature	X	X	X	X
*5. Label relevant equipment features	X	X	X	X
*6. Six labels per illustration	X	X	X	X
*7. Illustration and text next to each other	X	X	√	√
*8. Use line drawings	√	√	√	√
*9. Illustrate user's view	X	X	X	X
*10. Show hands or body features	X	X	X	O
*11. Use 2nd person imperative	√	√	√	√
*12. Use blow-ups to aid recognition	X	√	X	X
*13. Use minimum dimension of 1/4 inch	X	X	X	X
14. Use familiar words	√	√	√	√
15. Be explicit in describing user action	√	√	√	√

√ = Ok
O = Violates occasionally
X = Violates consistently
* = Illustrations involved.

Table 3 shows the results of reviewing the envelope presentations of the four sample NATOPS manuals against the five formatting rules. The A-7 manual fared the best complying with 3 of the 5 rules.

Table 3

Compliance of Four Sample Presentations (Envelope) Against Formatting Rules

	F-14	A-7	AV-8	F-4
1. Use graphic as primary	√	√	X	X
2. Use narrative to support graphic	X	X	X	X
3. Use directive form of instructions	√	√	O	O
4. Minimize need for translations	X	√	X	X
5. Provide graphic-narrative proximity	•	•	•	•

•Narrative-graphic not related; proximity rule is academic.
X = Major violation.
O = Occasional violation.
√ = Ok.

Subjectively, this review indicates that there is considerable room for improvement in the formatting of both procedural and envelope presentations of the NATOPS ejection presentations.

REFORMATTING SAMPLE PRESENTATIONS

Figures 1 and 2 show samples of the procedures and envelope presentations which were redone in accordance with the appropriate format rules. The results of this reformatting are shown in the figures referenced in the following discussions.*

Procedures Reformatting

The rationale for the procedural reformatting was to enhance recallability by providing a pictorial for *every step* of the procedure. This approach relies heavily on rules 4 and 5 of Figure 4. A second thrust of the reformatting was to heighten the visibility of the narrative statement of steps (rule 1) and to key each statement to its related pictorial. Figures 6 and 7 show samples of the results of pursuing this approach.

Envelope Reformatting

The envelope reformatting relied heavily on rules 3 (provide directive information) and 4 (avoid transforms). The rationale for this approach is as follows. The graphic portion of the envelope presentation is roundly criticized by pilots for its complexity, difficulty to remember and its form which prevents direct use. To compensate, users translate these charts into "rules of thumb" which are easier to use. Since users adopt this approach informally, it seems reasonable to provide rules of thumb developed by design engineers rather than professional aviators. Figure 8 shows a *hypothetical* rule of thumb and a simplified graphic chart related to the thumb rule. The logic for providing both is that some users prefer to see the chart to substantiate the rule of thumb.

The chart was simplified by eliminating half of the parametric curves (the crew can do nothing about altimeter lag or firing time delay, so why complicate the chart with their inclusion?); and by opening the grid (the level of accuracy implied by the fine grid of the original chart is not usable and complicates the presentation).

Although considerably simplified, Figure 8 still requires the pilot or crewmember to perform some mental translations to use these parametric charts and their supporting rules. Rule 5 was invoked to provide a more direct form of guidance. In essence, this approach identified frequently encountered flight situations which exceeded the limits of the ejection system. These situations would be portrayed pictorially along with an action statement regarding ejection in the marginal condition. Figure 9 presents a sample to illustrate this approach to presenting envelope information.

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*During the course of the project, format changes were suggested. Many of these changes will be implemented in subsequent investigations. However, the samples shown here reflect what the pilot and crewmembers were shown, not the ultimate version.

The original and reformatted versions of these NATOPS presentations were submitted to a group of flight personnel for their assessment. The results of this assessment are discussed in the next section.

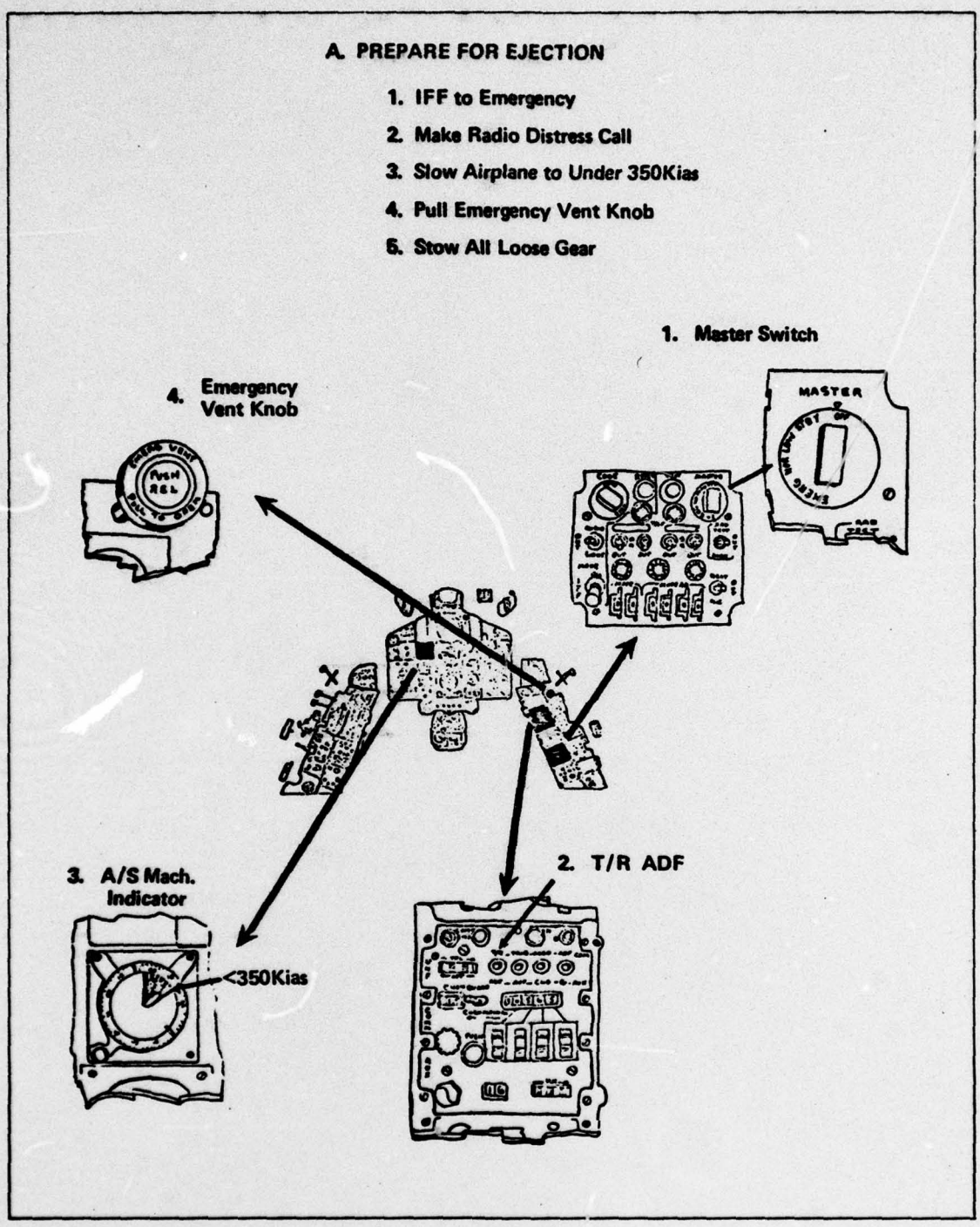


Figure 6. Reformatted Version of the "Prepare for Ejection" Sequence.

C. JETTISON CANOPY

1. Reach Overhead, with Palms Aft Keeping Elbows Together, Grasp Face Curtain Handle

2. Pull Face Curtain Handle and Maintain Downward Force Until Stop is Encountered

3. When Canopy Jettisons, Continue Pulling Face Curtain Handle Until Full Travel is Reached

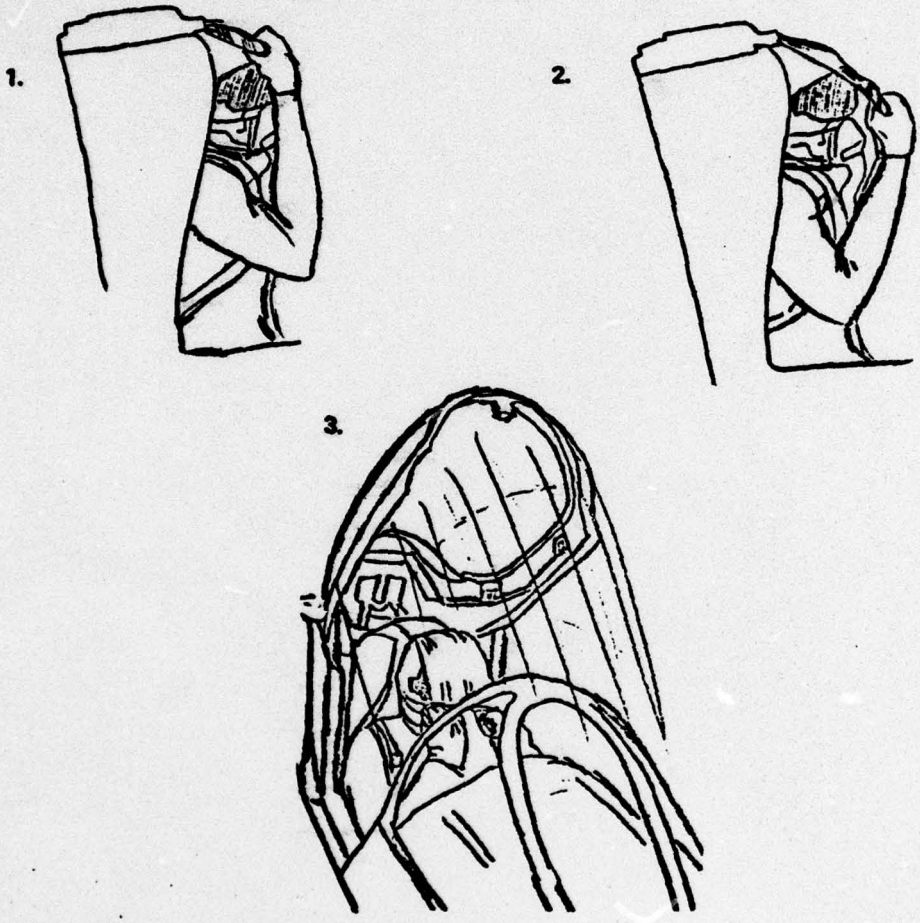
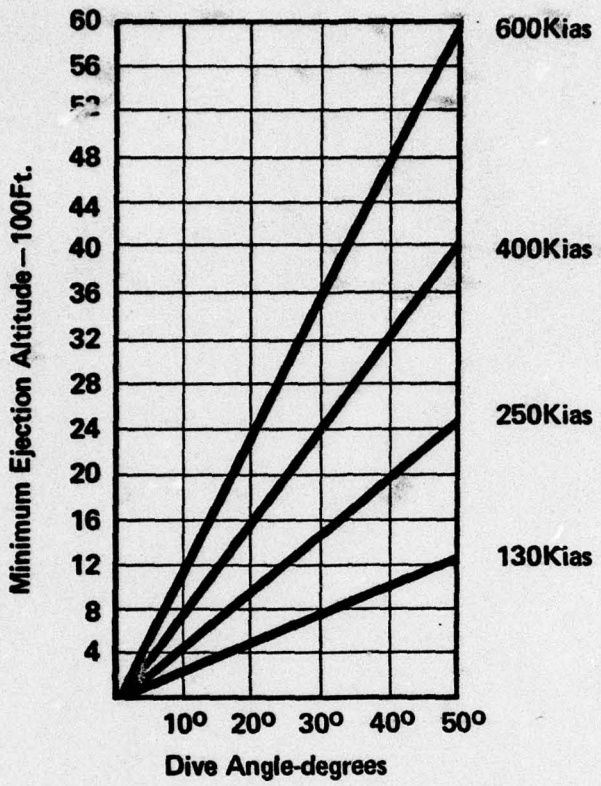


Figure 7. Reformatted Version of the "Jettison Canopy" Sequence.



Basic Rule: Altitude Should be 10X Airspeed.

Dive Angle Rule: If You are in a Dive and Your Altitude is Less Than 10X Airspeed and you are in Control of Aircraft Correct to Chart Values or to Basic Rule.

Emergency Rule: If Altitude is Less Than 10X Airspeed and You are Out of Control Go Immediately!

Figure 8. Reformatted Version of An Envelope Presentation.

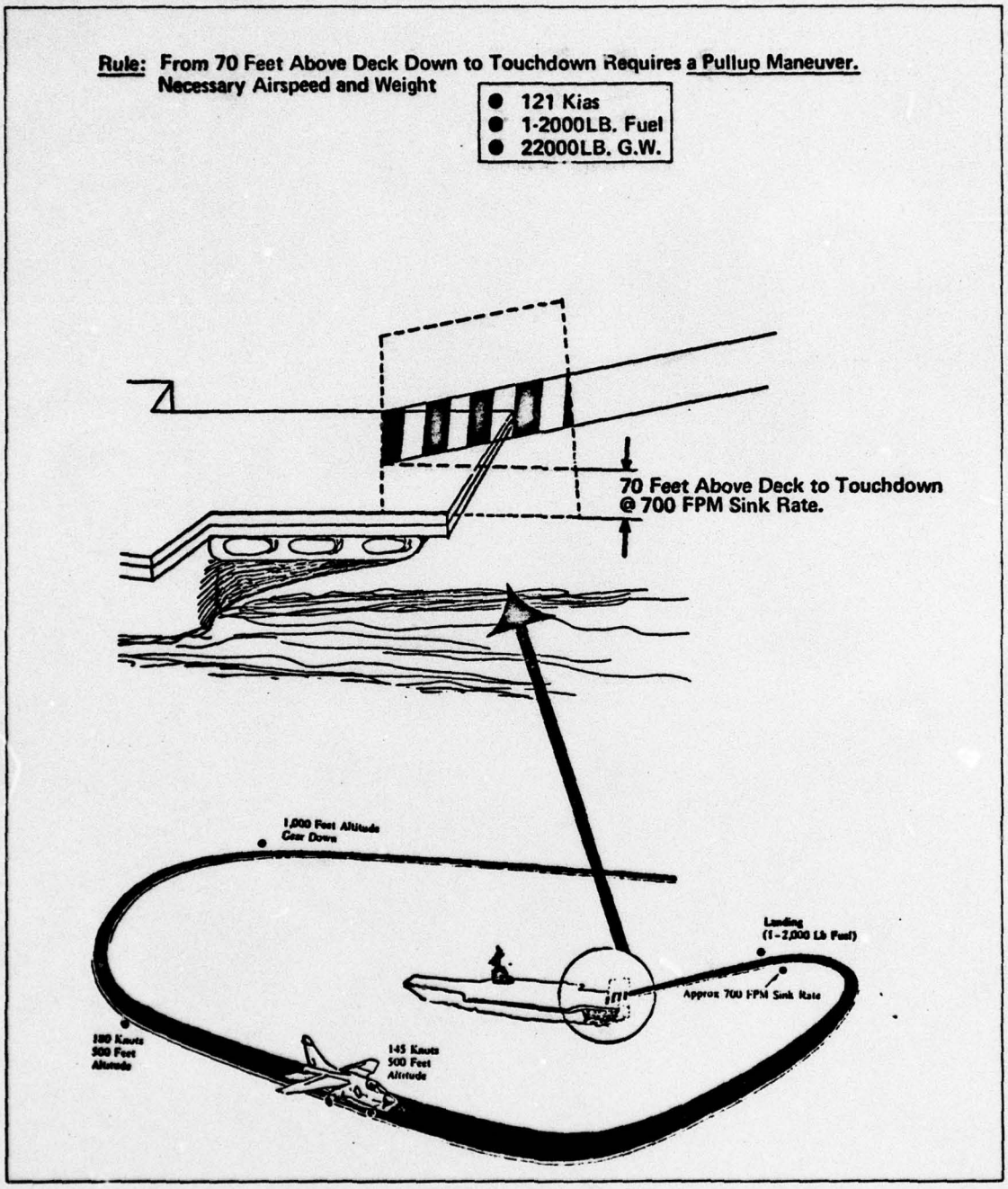


Figure 9. Envelope Reformatted to Emphasize Directive Instructions.

EVALUATION OF THE NEW FORMATS

For the purposes of this study it was felt that the opinions of expert users (pilots and crewmembers) would be the best basis for indicating clarity and recallability of the proposed formats. Accordingly, questionnaires were prepared to determine whether the current NATOPS or proposed versions were preferred and for what reasons. The items on the questionnaires concerned the formatting rules for the procedural and envelope information. Figures 10A and B show responses to the questionnaire items designed to assess the procedural formats while Figure 11 shows the responses to the questionnaire items designed to assess the envelope formats. Key points about the subject's responses for both formatting efforts are discussed below.

Procedural Responses

- The responses to the "boxed" items at the top of Figure 10A indicate that the majority of the respondents prefer the reformatted, alternative version. The preference seems strongest for layout of the narrative statements (96%), number of pictures shown (88%), and pictorial coverage of equipment items (85%). Weaker but still favorable support for the reformatted version was shown for its form of pictorials (69%) and detail shown (64%).

- A key feature of the alternative format is the increase in number of pages due to large amounts of white space to accommodate perceptual spacing and extra pictorials. There is concern that these extra pages may deter utilization, especially in the emergency section. As shown by responses to the "general" question subject opinion does not support this fear.

- The primary goal of the procedural reformatting is to enhance the user's ability to recall the information. The means chosen to achieve this goal are the heightened use of pictorials and the "mental rehearsal" which this feature is supposed to enable (Sitterly, 1974). Question 3 on Figure 10B was designed to assess whether the new formats achieve this goal. As shown, the respondents appear to understand and be in favor of this approach to learning.

Envelope Presentations

The questions regarding envelope presentations deal less with format and more with content or form of guidance (see Figure 11). Comments about the subjects' responses to these questions appear below.

- On the whole, subjects were in favor of all of the new format's features with the exception of the tabular-narrative option (question #1).

Questions on the Format of Ejection Procedures Descriptions

Format Features to be Rated	Current NATOPS	Alternative	No Difference
Drawings			
1. Pictorial coverage of equipment items mentioned in steps	11%	85%	4%
2. Number of pictures shown. .	4%	88%	8%
3. Form of pictures (photo or line drawings)	19%	69%	12%
4. Portrayal of arms and limbs	4%	73%	23%
5. Detail shown	12%	64%	24%
Text			
1. Layout of steps	4%	96%	--
2. Explicitness of statements	12%	84%	4%

General

1. The features of the alternative formats require more pages (4 to 5 times more). Do you think:

   15% [X] This will deter utilization.

   85% [X] The clarity improvement is worth it.

Figure 10A. Summary of Responses to Questions About Procedural Presentations

3. How often and for what lengths of time do you refer to the Ejection procedures in the Emergency section of the NATOPS manual?

Frequency		Duration	
☐	before every flight	☒	5 minute scan (41%)
☒	once a week (31%)	☒	10 minutes for study (59%)
☒	once a month (69%)	☐	20-30 minute review

Comments: _____

_____

_____

_____

4. Spend two minutes reviewing the new version of the ejection procedures. Concentrate on the equipment items and body movements involved in each step rather than the words describing each step. Now see if you can mentally run through this sequence without reference to the procedures?

(a) Can you do it?

100% ☒ yes ☐ no

(b) Do you think this approach to practice is useful?

100% ☒ yes ☐ no

(c) Do you think new formats with their emphasis on pictorials will encourage this mental rehearsal approach?

96% ☒ yes ☒ no

5. Do you have any comments to offer regarding the emergency section of the NATOPS manual?

_____

_____

_____

_____

Figure 10B. Summary of Responses to Questions About Procedural Presentations

QUESTIONS ON THE EJECTION ENVELOPE

1. Regarding the altitude and speed capabilities of the seat, do you prefer the tabular presentation or narrative discussion?

   57% [X] Tabular
   43% [X] Narrative Discussion

2. Do you prefer the detailed or simplified version of the Dive Angle chart?

   4% [X] Detailed
   96% [X] Simplified
   Why_____

3. Do the rules of thumb increase the usability of the Dive Angle chart?

   82% [X] Yes
   18% [X] No

4. Are the "rules of thumb" a reasonable approach to clarifying the question of when to eject?

   93% [X] Yes
   7% [X] No
   Comment:_____

5. Do you think the flight segment illustration adds to your understanding of the seat envelope?

   85% [X] Yes
   15% [X] No
   Comment:_____

6. If you think this approach is reasonable, in what section of the NATOPS manual does it belong?

   86% [X] Emergency
   14% [X] System description
   Other_____

Figure 11. Summary of Responses to Questions About Envelope Presentations

- Discussions following administration of the questionnaire indicated strong preference for the flight segment approach (illustrated in Figure 9). Basically, this approach is a variation of "proceduralization" wherein experts identify and analyze frequently encountered and critical situations for the purpose of telling the user how to cope with what otherwise would be a difficult problem.

- The rule of thumb feature which appears to satisfy the users is an attempt to formalize what most pilots and crewmembers appear to be doing informally and perhaps inaccurately.

Summary

Based on questionnaire responses and extensive discussion with pilots and crewmembers, the following observations are offered in the way of summary statements.

- The ejection presentations in the Emergency sections of typical NATOPS manuals appear to violate standard format rules.

- Users appear to be in favor of the proposed formats which emphasize pictorial presentations, practical guidance and recallability.

- Users do not appear to be aware of but seem to grasp quite readily the concept of "mental rehearsal" and the role which TM presentations can play in fostering this approach to learning.

- Users are especially concerned about the current envelope presentations characterizing them as difficult to use and lacking in practical guidance.

RECOMMENDATIONS

Two factors support a recommendation to conduct a more extensive and definitive evaluation of the formats developed and assessed during this study: (1) positive user response: and (2) possibility of reducing costly injury and loss of life. Some of the characteristics which a more extensive evaluation should include are discussed below.

1. The reformatting rules on learning and recall should be strengthened by considering techniques such as *dramatization* (support points with relevant accident statistics) and *Imaging* (a specific version of the mental rehearsal process).

2. The evaluation should be conducted in a training setting where the relevant materials can be used in support of a classroom or home study.

3. The evaluation setting should be as realistic as possible (viz., a simulator) covering a representative range of ejection scenarios. Subjects trained with current and reformatted information will be asked to respond to these scenarios.

4. The dependent variables of the evaluation should include compliance with envelope restrictions and with procedures, especially those related to safe egress.

5. The evaluation should assess initial learning and recall for current NATOPS and reformatted presentations.

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